JALBTCX

Joint Airborne Lidar Bathymetry Technical Center of Expertise

Results from the Lidar Survey Specifications Summit Meeting

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NAVAL METEOROLOGY AND OCEANOGRAPHY COMMAND

NAVAL OCEANOGRAPHIC OFFICE

NOAA

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

U.S. DEPARTMENT OF COMMERCE

Background

- 20+ attendees from 5 federal agencies
  - USACE, NAVO, NOAA, USGS, NGA
- Goal to develop common standards for airborne coastal mapping and charting
  - Bathy/Topo Lidar
  - RGB Imagery
  - Hyperspectral Imagery
- Support the IWG on Ocean & Coastal Mapping

Key Results

- Draft common specifications matrix
- Lidar Metadata template
- Standard Lidar exchange format
- Bathy Lidar Bulletin Board (CLICK)

Common Specifications Matrix

Data Description (metadata)

General	NAVOCEANO	USACE	NOAA	USGS	Consensus Items (application dependent)	
					Charting	Environmental, Modeling, Coastal Mapping Surveys
Sensor Information						
sensor type	describe in metadata	describe in metadata	describe in metadata	describe in metadata	describe in metadata	
sensor serial number	describe in metadata	describe in metadata	describe in metadata	describe in metadata	describe in metadata	
sensor calibration date	most recent lab and in situ calibrations with supporting documentation	most recent lab and in situ calibrations with supporting documentation	most recent lab and in situ calibrations with supporting documentation	most recent lab and in situ calibrations with supporting documentation	most recent lab and in situ calibrations with supporting documentation	
sensor offsets (lever arms)	contained in .prm file	describe in metadata	describe in metadata, absolute accuracy < 1 cm (1 sigma)	contained in ops_conf.i file	describe in metadata	
Collection Information						
environmental observations	relevant to processing	relevant to processing	relevant to processing	relevant to processing	relevant to processing	
aquisition date / time	included in .hof file	each shot	describe in metadata	each laser shot	describe in metadata	each laser shot
horizontal datum of acquisition	WGS84	NAD83	NAD83	WGS84(G1150)		
vertical datum of aquisition	WGS84	NAD83	NAD83	WGS84(G1150)		
metadata standard	open for discussion	FGDC	open for discussion	FGDC	Group will draft a lidar metadata template based on FGDC standards	

Hydrographic Lidar	NAVOCEANO	USACE	NOAA	USGS	Consensus Items (application dependent)	
					Charting	Coastal Mapping, etc.
Sensor Information						
scanner type	describe in metadata	describe in metadata	describe in metadata	describe in metadata	describe in metadata	
PRF	describe in metadata	describe in metadata	describe in metadata	describe in metadata	describe in metadata	
pulse width	describe in metadata	describe in metadata	describe in metadata	describe in metadata	describe in metadata	
Collection Information						
swath width	describe in metadata	describe in metadata	describe in metadata	describe in metadata	describe in metadata	
swath overlap	describe in metadata	describe in metadata	describe in metadata	describe in metadata	describe in metadata	
scan angle	describe in metadata	describe in metadata	describe in metadata	describe in metadata	describe in metadata	
scan rate	describe in metadata	describe in metadata	describe in metadata	describe in metadata	describe in metadata	
flying height (AGL)	describe in metadata	describe in metadata	describe in metadata	describe in metadata	describe in metadata	
peak transmitted laser power	describe in metadata	describe in metadata	describe in metadata	describe in metadata	describe in metadata	
beam divergence	describe in metadata	describe in metadata	describe in metadata	describe in metadata	describe in metadata	
tide-coordinated (y/n)	shoreline runs	shoreline runs	as specified in project instructions	PDOP Coordinated	Provide means of conversion to tidal datum	Perform at high tide when possible
horizontal shot spacing	3 m X 3m	5 m	2x2m @ 100% or 3x3m @ 200% or 4x4m @ 200% depending on tide range and other factors	1m x 1m	2x2m or 3x3m (spot spacing must be considered in conjunction with coverage - see NOAA)	4m postings

Topographic Lidar	NAVOCEANO	USACE	NOAA	USGS	Consensus Items (application dependent)	
					Charting	Coastal Mapping, etc.
Sensor Information						
scanner type	describe in metadata	describe in metadata	describe in metadata	describe in metadata	describe in metadata	
PRF	describe in metadata	describe in metadata	describe in metadata	describe in metadata	describe in metadata	
pulse width	describe in metadata	describe in metadata	describe in metadata	describe in metadata	describe in metadata	
Collection Information						
swath width	describe in metadata	describe in metadata	describe in metadata	describe in metadata	describe in metadata	
swath overlap	describe in metadata	describe in metadata	describe in metadata	describe in metadata	describe in metadata	
scan angle	describe in metadata	describe in metadata	describe in metadata	describe in metadata	describe in metadata	
scan rate	describe in metadata	describe in metadata	describe in metadata	describe in metadata	describe in metadata	
flying height (AGL)	describe in metadata	describe in metadata	describe in metadata	describe in metadata	describe in metadata	
peak transmitted laser power	describe in metadata	describe in metadata	describe in metadata	describe in metadata	describe in metadata	
beam divergence	describe in metadata	describe in metadata	describe in metadata	describe in metadata	describe in metadata	
tide-coordinated (y/n)	shoreline runs	shoreline runs	yes, as specified in project instructions	describe in metadata		Perform at low tide when possible
horizontal shot spacing	2 m X 2m	5 m	1 m, or as specified in project instructions	3m x 3m	1x1m	

RGB Imagery	NAVOCEANO	USACE	NOAA	USGS	Consensus Items (application dependent)		
					Charting	Coastal Mapping, etc.	Emergency Response
Sensor Information							
FOV	describe in metadata	describe in metadata	describe in metadata	describe in metadata		describe in metadata	
focal length	describe in metadata	describe in metadata	describe in metadata	describe in metadata		describe in metadata	
CCD dimensions	describe in metadata	describe in metadata	describe in metadata	describe in metadata		describe in metadata	
NIR band required (y/n)	describe in metadata	describe in metadata	yes (min lower band edge 850 nm)	describe in metadata		describe in metadata	
USGS Certification required	describe in metadata	describe in metadata	yes	describe in metadata		describe in metadata	
Collection Information							
flying height (AGL)	describe in metadata	describe in metadata	describe in metadata	describe in metadata		describe in metadata	
pixel ground resolution	20 cm	<= 25 cm	<= 50 cm, or as specified in project instructions	70 cm			
stereo coverage (y/n)	describe in metadata	describe in metadata	yes	describe in metadata		yes	
endlap/sidelap	describe in metadata	describe in metadata	60%/30%(min) or as specified in project	describe in metadata		60%/30%	
tide-coordinated (y/n)	describe in metadata	describe in metadata	yes (lines specified as requiring tidal coordination should be flown during those times when the stage of tide is in the appropriate range)	describe in metadata	Perform at low tide	Perform at low tide when possible	no
sun angle	describe in metadata	describe in metadata	>30 deg or as specified in project instructions	describe in metadata	>= 30-deg elevation	>= 20-deg elevation	>= 10-deg elevation
flight line patch permissible	describe in metadata	describe in metadata	yes, begin second portion of a patched line at least 2 images before the break was made	describe in metadata		describe in metadata	
Min visibility	describe in metadata	describe in metadata	8 miles	describe in metadata	8 miles		Ground visible

Hyperspectral Imagery	NAVOCEANO	USACE	NOAA	USGS	Consensus Items (application dependent)		
					Charting	Coastal Mapping, etc.	Emergency Response
Sensor Information							
FOV	describe in metadata	describe in metadata	describe in metadata	describe in metadata		describe in metadata	
focal length	describe in metadata	describe in metadata	describe in metadata	describe in metadata		describe in metadata	
chip dimensions	describe in metadata	describe in metadata	describe in metadata	describe in metadata		describe in metadata	
spectral range	380-1050nm	VNIR	describe in metadata	describe in metadata	VNIR	VNIR	RGB
number of spectral bands	288	224	describe in metadata	describe in metadata	4	36	3
spectral resolution	1nm	5.20 FWHM	describe in metadata	describe in metadata	NIR > 740 nm	20nm FWHM	
Collection Information							
flying height (AGL)	describe in metadata	describe in metadata	describe in metadata	describe in metadata		describe in metadata	
pixel ground resolution at ac	1.2 m X 0.4 m		describe in metadata	18-20 cm/pixel @ 300m operating altitude	50cm	20cm RGB	35-50 cm
tide-coordinated (y/n)	describe in metadata	describe in metadata	yes (lines specified as requiring tidal coordination should be flown during those times when the stage of tide is in the appropriate range)	describe in metadata		describe in metadata	
sun angle	describe in metadata	describe in metadata	>30 deg or as specified in	describe in metadata	>= 30-deg elevation	>= 20-deg elevation	>= 10-deg elevation
max. cloud cover					none on shoreline	30%	minimize

Common Specifications Matrix

- Each agency gathered their internal specifications on a number of acquisition and processing parameters

Hydrographic lidar	NAVOCEANO	USACE	NOAA	USGS
Data Processing Information				
data processing steps	describe in metadata	describe in metadata	describe in metadata or as speci	describe in metadata
water surface processing algorit	describe in metadata	describe in metadata	describe in metadata	describe in metadata
bottom detection logic	first return	strongest return	describe in metadata	describe in metadata
vertical datum conversion meth	application of WGS84 ellipsoid to datum distance	latest NGS geoid model, describe in metadata	VDatum	NGS code
horizontal datum projection me	N/A	describe in metadata	document	NGS code
method of data cleaning	manual, 4 person integrity	manual, fliers removed	describe in metadata or as specified in project instructions	manual
Product Information				
data format	.hof	ASCII	final product (NGS) = vector shoreline, final product (OCS) = nautical chart	NETCDF
horizontal datum	WGS84	NAD83	NAD83	WSG84(G1150)
vertical datum	chart datum (MLLW)	NAVD88	MHW / MLLW	WSG84(G1150)
horizontal accuracy	IHO Order 1, depth dependant, < 0.7 m	2 m 2σ	dependant on scale of nautical chart	1m
vertical accuracy	IHO Order 1, depth dependant, < 1.8 m	25 cm 2σ	as specified in project instructions	15cm

Common Specifications Matrix

- Where possible, consensus was reached based upon different applications.

Hydrographic lidar	Consensus Items (application dependent)	
	Charting	Environmental, Modeling, Coastal Mapping Surveys
Data Processing Information		
data processing steps	describe in metadata	
water surface processing algorit	describe in metadata	
bottom detection logic	"True" last return	Threshold detect -2 returns
vertical datum conversion meth		
horizontal datum projection me		
method of data cleaning		manual
Product Information		
data format		
horizontal datum		
vertical datum		
horizontal accuracy	IHO Order 1 (~5.0m at 2σ)	2.0m at 2σ
vertical accuracy	IHO Order 1 (~0.5m at 2σ)	0.3m at 2σ

Common Specifications Matrix

- Considered:
  - Bathy/Topo Lidar
  - RGB Imagery
  - Hyperspectral Imagery
- Subdivided spec. based on application:
  - Charting
  - Environmental modeling, coastal mapping surveys
  - Emergency response

Common Specifications Matrix

- Topics of discussion:
  - Metadata
  - Data Collection Info
  - Positioning
  - Data Processing Info
  - Derived Product Info
  - QA/QC

- Results posted to JALBTCX website:
www.jalbtcx.org/standards.aspx

Common Specifications Matrix

Quality Assurance / Quality Control

Hydrographic lidar	Consensus Items	
	Coastline Survey	"Offshore" Survey
QA/QC Information		
ground truth		
cross check line comparisons	Every 25km (Ideally performed 1-3 days prior to mainscheme acq. for coastal applications)	Ensure 90% of mainscheme lines are crossed
line-to-line comparison	Should be performed	
repeat-line comparison	One interday line performed per day (ideally survey same line every day - like over ground control or GPS base station)	
ground truth comparison	In descending order of desirability: junction survey, beach profile, leadline, historic data	
Documentation	All QA/QC procedures should be documented to a level of permitting replication by a future user.	
Topographic lidar	**Consensus Items**	
	Coastline Survey	"On shore" Survey
QA/QC Information		
ground truth	For every 100 linear miles, collect 20 check points per environment surveyed (grass, under cover, hard ground) with a minimum of 30 points	No control point should be more than 10 miles from a laser spot (still with a minimum of 30 check points)

All systematic biases should be removed from data such that preceding comparisons satisfy (±10 cm vertical at 2σ) - document observed bias.

This should include level of human involvement (vs. autoprocessing), a survey-scale qualitative check discussing any spatial distribution of errors, quantifying biases noted in above comparisons (cross-check, etc.).

Federal Workshop Metadata Outcome

- FGDC Compliant metadata
- Most are moving to XML format (easier to automate metadata generators)

- Even though metadata is FGDC compliant, it does not always include enough information to determine if the data will meet your needs
- Additional Keyword Thesauri help metadata harvesters increase the distribution of the data
- Addition of a “Lidar” section to the metadata file

- Group formed from USGS, NOAA, and USACE to address these issues and produce a template and examples

Federal Workshop Metadata Outcome

Abstract:

Description of data set contents including, but not limited to, survey platform, sensor information (i.e. sensor type, resolution), data coverage, data processing, data product details (i.e. data file format, file naming conventions), and spatial reference information. Provides the data user enough basic information to be able to determine if the data set will meet their project needs.

Purpose:

Description of the intended use and limitations of the data set.

Supplemental Information: Additional details related to data acquisition and processing.

Keyword Thesaurus:

ISO 19115 Topic Category, NASA/Global Change Master Directory (GCMD) Earth Science Keywords, GCMD Instrument Keywords, GCMD Data Center Keywords

Lidar Metadata Section

GPS Sensor Information
- Monument Information
- Observation Information
    - Antenna type, serial number, etc.
    - Receiver type, serial number, etc.
    - Rover information
    - Length of collection, max distance from rover, max PDOP, max bank of rover

Inertial Reference Information
- IMU information
    - Type, model, serial number, calibration, orientation

Topographic Lidar Laser
- Type, serial number, calibration date, PRF, distance between returns, swath width, power, divergence, area of ground covered by spot

Hydrographic Lidar Laser
- Type, serial number, calibration date, PRF, distance between returns, swath

Lidar Metadata Section

Camera Information

- Type, model, serial number, field of view, focal length, CCD resolution, calibration date

Hyperspectral Information

- Type, model, serial number, field of view, focal length, calibration date, CCD
specs, spectral range, amount of bands, band width

Camera Collection Information

- AGL, ground resolution, stereo coverage (Boolean), end lap, side lap, tide
coordinated (Boolean), min sun angle, visibility, flight line patch (Boolean)

Hyperspectral Collection Information

- AGL, ground resolution, side lap, tide coordinated (Boolean), min sun angle

Comparison of data between flight lines

- Detailed description of flight line QA/QC comparison

-Distance between crossing lines, vertical separation of crossing lines, line-to-lines, and repeat lines

Lidar Metadata Section

Topographic Lidar Processing
- Return type, processing algorithm, horizontal/vertical datum conversion
method/model, data cleaning/editing method/model

Hydrographic Lidar Processing
- water surface algorithm, bottom detection logic/algorithm, horizontal/vertical
datum conversion method/model, data cleaning/editing method/model

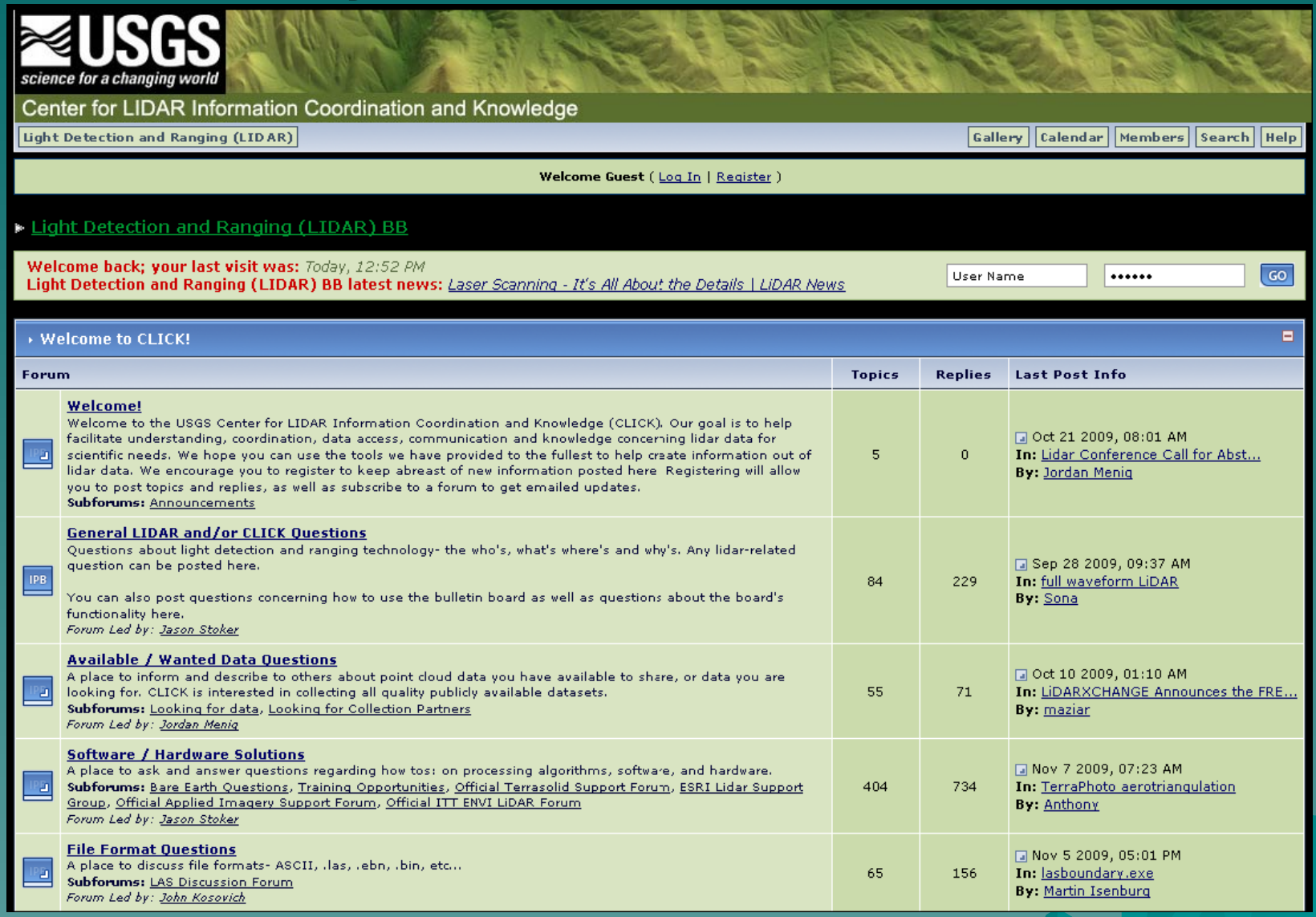
RGB Image Processing
- Orthorectification processing method, processing algorithm, horizontal datum
conversion method/model

Hyperspectral Image Processing
- Orthorectification processing method, processing algorithm, horizontal datum
conversion method/model

Lidar Exchange Format

- To develop a standard data format for lidar data
- Developed among Jan Depner (NAVO) Amar Nayegandhi (USGS)

Bathy Lidar Bulletin Board



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Forum	Topics	Replies	Last Post Info
Welcome! Welcome to the USGS Center for LIDAR Information Coordination and Knowledge (CLICK). Our goal is to help facilitate understanding, coordination, data access, communication and knowledge concerning lidar data for scientific needs. We hope you can use the tools we have provided to the fullest to help create information out of lidar data. We encourage you to register to keep abreast of new information posted here Registering will allow you to post topics and replies, as well as subscribe to a forum to get emailed updates. **Subforums:** Announcements	5	0	Oct 21 2009, 08:01 AM **In:** Lidar Conference Call for Abst... **By:** Jordan Menig
General LIDAR and/or CLICK Questions Questions about light detection and ranging technology- the who's, what's where's and why's. Any lidar-related question can be posted here. You can also post questions concerning how to use the bulletin board as well as questions about the board's functionality here. *Forum Led by: Jason Stoker*	84	229	Sep 28 2009, 09:37 AM **In:** full waveform LiDAR **By:** Sona
Available / Wanted Data Questions A place to inform and describe to others about point cloud data you have available to share, or data you are looking for. CLICK is interested in collecting all quality publicly available datasets. **Subforums:** Looking for data, Looking for Collection Partners *Forum Led by: Jordan Menig*	55	71	Oct 10 2009, 01:10 AM **In:** LiDARXCHANGE Announces the FRE... **By:** maziar
Software / Hardware Solutions A place to ask and answer questions regarding how tos: on processing algorithms, software, and hardware. **Subforums:** Bare Earth Questions, Training Opportunities, Official Terrasolid Support Forum, ESRI Lidar Support Group, Official Applied Imagery Support Forum, Official ITT ENVI LiDAR Forum *Forum Led by: Jason Stoker*	404	734	Nov 7 2009, 07:23 AM **In:** TerraPhoto aerotriangulation **By:** Anthony
File Format Questions A place to discuss file formats- ASCII, .las, .ebn, .bin, etc... **Subforums:** LAS Discussion Forum *Forum Led by: John Kosovich*	65	156	Nov 5 2009, 05:01 PM **In:** lasboundary.exe **By:** Martin Isenburg

Bathy Lidar Bulletin Board

- CLICK - *http://lidarbb.cr.usgs.gov*
- Hosted by USGS

A forum to facilitate understanding, coordination, data access, communication and knowledge concerning lidar data for scientific needs.

- Give Jason a chance to plug CLICK